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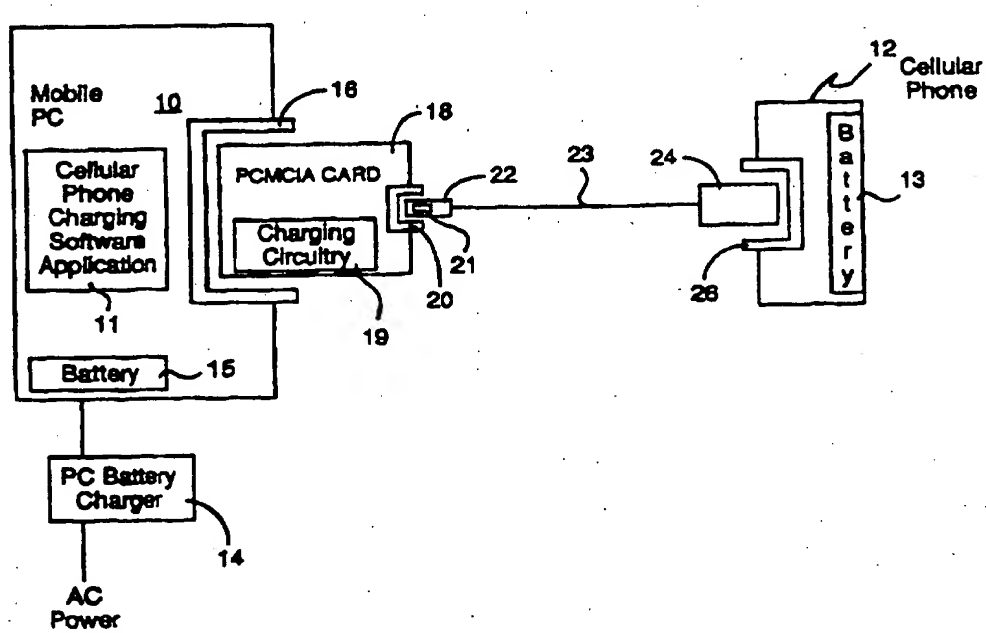

(57) Abstract

A PCMCIA card (18) having cellular phone battery charging circuitry (19), and an adapter cable (23) having a PCMCIA card connector (22) equipped with a battery characteristic encoder (21), are provided to charge a cellular phone battery (13), using power supplied by a mobile PC (10), in accordance to battery characteristic information provided by the battery characteristic encoder (21). Starting and stopping of charging operation is preferably controlled by mobile PC (10). Furthermore, starting and stopping of charging operation is preferably automated with charging software application (11) executing on mobile PC (10).

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Automatic Cellular Phone Battery Charging By Mobile Personal Computer

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of cellular phone battery. More specifically, the present invention relates to the charging of cellular phone battery by mobile personal computer (PC).

2. Background Information

Today, cellular phone and mobile PC have become indispensable business equipment to many business and technical professionals, particularly those who travel frequently. Typically, users who travel with both of these equipment would carry two separate incompatible battery chargers, one for charging the cellular phone battery, and the other for charging the mobile PC battery. This prior art approach to charging the various batteries is cumbersome and less than desirable. It would be a lot more desirable if one of the battery chargers can be eliminated. As will be disclosed in more details below, the present invention provides for a method and apparatus for charging the cellular phone battery by the mobile PC that achieves the desired and other results.

SUMMARY OF THE INVENTION

The desired results are advantageously achieved by providing an otherwise conventional PCMCIA card with additional cellular phone battery charging circuitry, and an otherwise conventional adapter cable with a PCMCIA card connector at one end, having a battery characteristic encoder. The adapter cable in conjunction with the PCMCIA card couples the cellular phone battery to a mobile PC. The cellular phone battery charging circuitry, using power supplied by the mobile PC, charges the cellular phone battery, in accordance to battery characteristic information provided by the battery characteristic encoder. Preferably, starting and stopping operation of cellular phone battery charging circuitry is controlled by mobile PC.

In one embodiment, the cellular phone battery charging circuitry comprises a two stage DC-DC converter and an addressable flip-flop. <<The first stage is used to ramp up the voltage and the second stage serves as a limited current adjustable power supply.>> The battery characteristic encoder comprises a number of control lines strapped in a cellular phone battery specific manner, denoting the cellular phone battery's required charging voltage, current and slope profile. Mobile PC is provided with a cellular phone battery charging software application including a monitor routine for automatically controlling operation of cellular phone battery charging circuitry and an end user interface for customizing the control of cellular phone battery charging circuitry.

In an alternate embodiment, battery characteristic encoder comprises a number of resistors for providing charging voltage, current, and slope feedback to the mobile PC.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will be described by way of exemplary embodiments, but not limitations, illustrated in the accompanying drawings in which like references denote similar elements, and in which:

Figure 1 illustrates charging of a cellular telephone battery by a mobile PC in accordance to the teachings of the present invention;

Figure 2 illustrates one embodiment of the PCMCIA card of **Figure 1** in further detail;

Figures 3a-3b illustrate two embodiments of the PCMCIA connector end of the connecting cable of **Figure 1** in further detail;

Figure 4 illustrates an architectural view of one embodiment of the mobile PC of **Figure 1**;

Figure 5 illustrates a software view of one embodiment of the mobile PC of **Figure 1**;

Figures 6a - 6b illustrate two exemplary user interface windows of cellular phone battery charger application of **Figure 5**.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, for purposes of explanation, specific numbers, materials and configurations are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced without the specific details. In other instances, well known features are omitted or simplified in order not to obscure the present invention.

Figure 1 illustrates charging of cellular phone battery **13** by a mobile PC **10** in accordance to the present invention. More specifically, battery **13** of cellular phone **12** is charged by charging circuitry **19** of the present invention, provided to PCMCIA card **18**, using DC power of mobile PC **13**, and in accordance to charging parameter information provided by battery characteristic encoder **21** of the present invention, provided to PCMCIA connector **22** of adpater cackle **23**. Charging parameter information includes required charging voltage, charging current and charging slope of battery **13**.

Cellular phone **12** includes battery **13** and adapter socket **26**. Battery **13** of cellular phone **12** is designed to supply cellular phone **12** with DC power, enabling cellular phone **12** to operate in standalone mode for an extended period of time without being connected to an AC power source. Battery **13** by way of examples may be NI-CAD or NI-MH type of batteries. Operation includes making and

receiving calls as well as stand by to receive calls. As the DC power of battery **13** are drained or consumed by cellular phone **12**, battery **13** must be recharged. Unlike the prior art approach of removing battery **13** from cellular phone **12** and recharging it using an "off-line" battery charger, under the present invention, battery **13** is recharged with battery **13** remain installed in cellular phone **12**.

Adapter socket **26** is used for delivering the charging power to battery **13**. Preferably, adapter socket **26** is simply a conventional adapter socket for receiving DC power from a DC power source, such as a car cigarette lighter, found in most cellular phones. Thus, except for the manner battery **13** is charged under the present invention, cellular phone **12** including its battery **13** and adapter socket **26** is intended to represent a broad category of cellular phones known in the art. Their constitutions and functions are well known and will not be otherwise further described.

Cellular phone **12** including battery **13** and adapter socket **23** is coupled to PCMCIA card **18**, by way of adapter cable **23**. Adapter cable **23** includes a cellular phone connector **24** at one end, and a PCMCIA connector **22** at the other end. Cellular phone connector **24** mates with adapter socket **26**, whereas PCMCIA connector **22** mates with receiver socket **20** of PCMCIA card **22**. For the illustrated embodiment, cellular phone connector **24** is simply a conventional cellular phone connector found in many prior art adapter cables, whereas PCMCIA connector **22** is provided with battery characteristic

encoder **21** of the present invention. However, based on the description to follow, it will be apparent to those skilled in the art that charging characteristic encoder **21** may also be disposed in cellular phone connector **24** instead. As will be described in more detail below, battery characteristic encoder **21** is cellular phone battery type specific. In other words, adapter cable **23** is cellular phone battery type specific. Except for charging characteristic encoder **21**, adpater cable **23** is intended to represent a broad category of like elements known in the art, whose constitutions and functions are well known, and will not be otherwise further described. Battery characteristic encoder **21** will be described in more detail below with additional references to **Figures 3a - 3b**.

PCMCIA card **18** comprises the earlier described receiver socket **20** and cellular phone battery charging circuitry **19** of the present invention. Except for cellular phone battery charging circuitry **19**, PCMCIA card **18** is intended to represent a broad category of such cards known in the art, including but not limited to fax/modem cards. In view of the close functional relationship between fax/modem PCMCIA cards and cellular phones, fax/modem PCMCIA cards are actually ideal candidates for incorporating the cellular phone battery charging circuitry **19** of the present invention. The constitutions and functions of the various PCMCIA cards available in the market are well known, and will not be otherwise further described. Cellular phone battery charging circuitry **19** will be described in more detail below with additional references to **Figure 2**.

PCMCIA card **18** is coupled to mobile PC **10** by way of receiver socket **16**. Mobile PC **10** in turn may be connected to an AC power source via PC battery charger **14**. However, it will be apparent to those skilled in the art from the description to follow that the present invention may be practiced with or without mobile PC **10** being connected to an AC power source. Furthermore, the present invention may be practiced with non-mobile computers provided they are equipped to receive PCMCIA card **18** or use a similar card designed for a PC local bus (e.g. EISA, ISA or PCI). By way of example, non-mobile computers may be a properly equipped desktop PC at the traveling user's home or destination location.

In addition to receiver socket **16**, mobile PC **10** further comprises battery **15** and preferably means for controlling starting and stopping operation of cellular phone battery charging circuitry **19** of PCMCIA card **18**. Preferably, receiver socket **16** is simply a standard conforming PCMCIA card receiver socket. In one embodiment, means for controlling starting and stopping operation of cellular phone battery charging circuitry **19** includes cellular phone battery charging software application **11**. Except for cellular phone battery charging software application **11**, mobile PC **10** is intended to represent a broad category of mobile PCs known in the art, whose constitutions and functions are well known, and will not be otherwise further described. An exemplary cellular phone battery charging software application **11** will be

described in more detail below with additional references to **Figures 4 - 6.**

Having given an overview description of the present invention, cellular phone battery charging circuitry **19**, battery characteristic encoder **21** and an exemplary cellular phone battery charging software application **11** will now be further described in order with additional references to the remaining figures. However, before describing these elements of the present invention in detail, it should be noted that in view of the novel placements of the various hardware/software elements, the present invention may be advantageously practiced without requiring any modifications to cellular phones **12** and mobile PC **10** (except loading of software application **11**).

Figure 2 illustrates one embodiment of cellular phone battery charging circuitry **19** and PCMCIA card **18** in further detail. For the illustrated embodiment, cellular phone battery charging circuitry **19** includes DC-DC converter **44** and an addressable flip-flop **40** coupled to each other as shown. Additionally, DC-DC converter **44** is coupled to mobile-PC **10** by way of power input line **34** and standard conforming PCMCIA plug **28**, and to adapter cable **23** by way of control signal lines **46**, power output line **48** and receiver socket **20**.

<<DC-DC converter **44** is a two stage DC-DC converter. The first stage is used to ramp up the PCMCIA voltage (5v) to a higher

voltage (e.g. 15v). The second stage serves as a limited current adjustable power supply. Suitable DC-DC converters for the first stage include MAX 772 5-15v 1A DC-DC converter manufactured by MAXIM Integrated Products of Sunnyvale, CA, and suitable DC-DC converters for the second stage include LM205 manufactured by National Semiconductors of Santa Clara, CA. >>

DC-DC converter **44** is turn on or off by flip-flop **40**. While in an "On" state, DC-DC converter **44** receives DC power from power input line **34**, and outputs converted DC power on power output line **48**, in accordance to charging parameter information received over control signal lines **46**. As described earlier, the charging parameter information includes the required charging voltage, charging current and charging slope of battery **13**.

Flip-flop **40** is coupled to PCMCIA interface circuitry **30** by way of a data input line **36** and a load control line **38**. As shown, PCMCIA interface circuitry **30** includes address decoding circuitry **32**. Flip-flop **40** is mapped in PCMCIA configuration space. Flip-flop **40** is set and reset by mobile PC **10**, by writing a "1" and a "0" bit to the particular PCMCIA configuration address.

While the cellular phone battery charging circuitry **19** has been described with an embodiment having its DC-DC converter **44** turn on/off by addressable flip-flop **40**, it is readily apparent to those

skilled in the art that DC-DC converter **44** may be turned on/off by a variety of other simple hardware and software approaches.

Figures 3a - 3b illustrate two embodiments of battery characteristic encoder **21** in further detail. **Figure 3a** illustrates an analog approach, whereas **Figure 3b** illustrates a digital approach. For the analog embodiment, battery characteristic encoder **21** includes shunt resistor R1 for providing current feedback, resistors R2 and R3 for providing voltage feedback, and resistor R4 for selecting the charging slope. The values for resistors R1 - R4 are cellular phone battery specific. <<By way of example, for a M715 battery used in NOKIA Cityman cellular phone (7.2v 850 mAhr), the resistances of R1-R4 are 9.5K, 3.15K, 0.4, and 360 ohms respectively.>> For the digital embodiment, five control lines **46** are provided to select one of thirty-two predetermined charging voltage, current and slope combinations (2**5 = 32). The particular strapping of control lines **46** is cellular phone battery specific.

Figure 4-5 and **6a-6b** illustrate one exemplary cellular phone battery charging software application **11**. **Figure 4** illustrates the relevant hardware elements of mobile PC **10** executing exemplary cellular phone battery charging software application **11**. **Figure 5** illustrates other software elements on mobile PC **10**. **Figure 6a - 6b** illustrate two essential end user interface windows **134a - 134b** of exemplary cellular phone battery charging software application **11**.

As illustrated in **Figure 4**, mobile PC **10** includes CPU **110**, cache memory **114**, main memory **118**, memory controller **116** and CPU bus **112** coupled to each other as shown. Mobile PC **10** further comprises bus controller **120**, various I/O devices **124** and I/O bus **122** coupled to each other as shown. Memory controller **118** and bus controller **120** are also coupled to each other. PCMCIA card **18** incorporated with the teachings of the present invention is coupled to I/O bus **122**. Additionally, bus controller **120** includes BIOS registers (not shown) for storing control and status information of battery **15** of mobile PC **10** and BIOS firmware for detecting the status of battery **15** and storing the control and status information into BIOS registers accordingly. Control and status information includes in particular the charge level of battery **15**.

As illustrated in **Figure 5**, in addition to exemplary cellular phone battery charging application **11**, mobile PC **10** further preferably executes a window based operating system **126** including window subsystem **128** for providing various system services including "windowing" services for presenting windowed end-user interfaces to user of mobile PC **10**. Exemplary cellular phone battery charging application **11** includes end user interface **134** and monitor routine **136**. Monitor routine **136** monitors the above described BIOS registers for predefined conditions. Whenever the predefined conditions are satisfied, monitor routine **136** starts/stops operation of cellular phone battery charging circuit **19** accordingly. For the above described embodiment where addressable flip-flop **40** is employed, monitor

routine **136** starts and stops operation of cellular phone battery charging circuit **19**, by writing to the predetermined configuration address in the PCMCIA configuration space.

As illustrated in **Figures 6a - 6b**, end user interface **134** includes first and second windows **134a - 134b**. From first window **134a**, user of mobile PC **10** may select automatic charging of cellular phone battery **13**, button **138**, and a PC battery condition for governing the starting/stopping of cellular phone battery charging, input box **142**. User of mobile PC **142** may further specify the locations of the above described BIOS registers and other related control information indirectly, by selecting one of a number supported mobile PC types (brand A, brand B etc.), selection box **140**. These information by PC type may be provided to the cellular phone charging application **11** either statically or dynamically. From second window **134b**, which is displayed upon selection of the "manual" way of providing the locations of the above described BIOS registers and other related control information in first window **134a**, user of mobile PC **10** may specific the starting address of the BIOS registers, input box **146**, as well as first and second bit patterns for denoting charging of cellular phone battery is active or inactive. As illustrated, in either window **134a** or **134b**, user of mobile PC **10** is also provided with the ability to disable cellular phone battery charging, button **136**, and the ability to enable cellular phone battery charging unconditionally, button **144**.

Thus, a method and apparatus for automatic cellular phone battery charging by mobile personal computer has been described. While the methods and apparatus of the present invention have been described in terms of the above illustrated embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments described. The present invention can be practiced with modification and alteration within the spirit and scope of the appended claims. The description is thus to be regarded as illustrative instead of restrictive on the present invention.

CLAIMS

What is claimed is:

1. A PCMCIA card comprising:

a) a first connector for mating with a receiver socket of a computer and receiving first DC power at a first voltage level from the computer through the receiver socket;

b) cellular phone battery charging circuitry coupled to the first connector for receiving the first DC power, converting the first DC power to second DC power at a second voltage level in accordance to battery charging parameter information received, and outputting the second DC power;

c) a second connector coupled to the cellular phone battery charging circuitry for coupling the cellular phone battery charging circuitry to a battery characteristic encoder for receiving the battery charging parameter information from the battery characteristic encoder and passing on the battery charging parameter information to the cellular phone battery charging circuitry, and for coupling the cellular phone battery charging circuitry to a cellular phone battery for receiving the second DC power from the cellular battery charging circuitry and charging the cellular phone battery with the second DC power.

2. The PCMCIA card as set forth in claim 1, wherein the cellular phone battery charging circuitry comprises a DC-DC converter coupled to the first and second connectors for receiving the first DC power,

converting the first DC power to the second DC power in accordance to the cellular phone battery charging parameter information received, and outputting the second DC power.

3. The PCMCIA card as set forth in claim 2, wherein the cellular phone battery charging circuitry further comprises a flip-flop coupled to the DC-DC converter for outputting an enabling/disabling signal for enabling/disabling the DC-DC converter.

4. The PCMCIA card as set forth in claim 3, wherein

the first connector is further equipped to receive addresses and data from the computer for setting/resetting the flip-flop to output the enabling/disabling signal;

the PCMCIA card further comprises PCMCIA interface circuitry coupled to the first connector, including address decoding circuitry, for responding to the received addresses and data;

the flip-flop is further coupled to the PCMCIA interface circuitry and mapped to an configuration address of a PCMCIA configuration address space.

5. A cellular phone adapter cable comprising:

a first connector for mating with a PCMCIA card, providing the PCMCIA card with battery charging parameter information, and receiving DC power output by the PCMCIA card in accordance to the battery charging parameter information provided;

a cable having a first end coupled to the first connector for transporting the DC power;

a second connector coupled to a second end of the cable for mating with a cellular phone for providing the DC power to the cellular phone including charging a battery of the cellular phone.

6. The cellular phone adapter cable as set forth in claim 5, wherein the first connector comprises a battery characteristic encoder for providing the battery charging parameter information to the PCMCIA card.

7. The cellular phone adapter cable as set forth in claim 6, wherein the battery characteristic encoder comprises a plurality of resistors for providing a charging voltage feedback, a charging current feedback, and a charging slope feedback to the PCMCIA card as the battery charging parameter information.

8. The cellular phone adapter cable as set forth in claim 6, wherein the battery characteristic encoder comprises a plurality of control lines strapped in manner to denote one of a plurality of predetermined charging voltage, charging current, and charging slope combinations as the battery charging parameter information.

9. The cellular phone adapter cable as set forth in claim 5, wherein,

the second connector comprises a battery characteristic encoder for providing the battery charging parameter information to the PCMCIA card; and

the cable further transports the battery charging parameter information.

10. A mobile personal computer (PC) comprising:

a receiver socket for mating with a PCMCIA card having cellular phone battery charging circuitry, and supplying first DC power at a first voltage level and control signals to the cellular phone battery charging circuitry, the control signals enabling/disabling the cellular battery charging circuitry, and when enabled, the cellular battery charging circuitry converting the first DC power to a second DC power at a second voltage level in accordance to charging parameter information received, and outputting the second DC power; and

control means coupled to the receiver socket for generating the control signals for the cellular phone battery charging circuitry.

11. The mobile PC as set forth in claim 10, the control means comprises writing means coupled to the receiver socket for generating the control signals by selectively writing a "1" bit or a "0" bit to a predetermined configuration address of a PCMCIA configuration address space.

12. The mobile PC as set forth in claim 10, wherein

the mobile PC further comprises a battery for supplying DC power to the mobile PC; and

the control means comprises

one or more BIOS registers for storing control and status information of a battery of the mobile PC, and

monitor means coupled to the BIOS register(s) for monitoring the stored control and status information and detecting for a predetermined condition.

13. The mobile PC as set forth in claim 12, wherein the control means automatically generates the control signals whenever monitor means detects the predetermined condition.

14. The mobile PC as set forth in claim 13, wherein the mobile PC further comprises a power adapter coupled to an AC power source and the battery for transforming AC power into DC power for charging the battery.

15. The mobile PC as set forth in claim 10, wherein the control means comprises an end user interface for accepting user preferences and/or commands related to the generation of the control signals for the cellular phone battery charging circuitry.

16. A computer comprising:

a receiver socket for mating with a PCMCIA card having cellular phone battery charging circuitry, and supplying first DC power at a first

voltage level and control signals to the cellular phone battery charging circuitry, the control signals enabling/disabling the cellular battery charging circuitry, and when enabled, the cellular battery charging circuitry converting the first DC power to second DC power at a second voltage level in accordance to charging parameter information received, and outputting the second DC power;

control means coupled to the receiver socket for generating the control signals for the cellular phone battery charging circuitry.

17. The computer as set forth in claim 16, the control means comprises writing means coupled to the receiver socket for generating the control signals by selectively writing a "1" bit or a "0" bit to a predetermined configuration address of a PCMCIA configuration address space.

18. A mobile computing system comprising:

a) a mobile personal computer (PC) including a first battery for outputting first DC power at a first voltage level;

b) a PCMCIA card, including a cellular phone battery charging circuitry, coupled to the mobile PC for converting the first DC power into second DC power at a second voltage level in accordance to battery charging parameter information provided, and outputting the second DC power; and

c) a cellular phone adapter cable for providing the battery charging parameter information to the cellular phone battery charging

circuitry of PCMCIA card, and for coupling the second DC power to a second battery of a cellular phone for charging the second battery.

19. The mobile computing system as set forth in claim 18 wherein the mobile computing system further comprises the cellular phone including the second battery.

20. The mobile computing system as set forth in claim 18 wherein the mobile PC comprises a.1) a receiver socket for mating with the PCMCIA card, and supplying the first DC power to the cellular phone battery charging circuitry of PCMCIA card.

21. The mobile computing system as set forth in claim 20, wherein the mobile PC further comprises a.2) control means coupled to the receiver socket for generating control signals for enabling/disabling the cellular phone battery charging circuitry of PCMCIA card through the receiver socket.

22. The mobile computing system as set forth in claim 18 wherein the PCMCIA card comprises:

b.1) a first connector for coupling the PCMCIA card to the mobile PC and receiving the first DC power at the first voltage level;

b.2) the cellular phone battery charging circuitry coupled to the first connector for receiving the first DC power, converting the first DC power into the second DC power at the second voltage level in

accordance to the battery charging parameter information received, and outputting the second DC power; and

b.3) a second connector coupled to the cellular phone battery charging circuitry for coupling the PCMCIA card to the cellular phone adapter cable for receiving the battery charging parameter information from the cellular phone adapter cable and passing on to the cellular phone battery charging circuitry, and for receiving the second DC power and passing on the second DC power to the cellular phone adapter cable.

23. The mobile computing system as set forth in claim 18 wherein the cellular phone adapter cable comprises:

c.1) a first connector for mating the cellular phone adapter cable with the PCMCIA card, providing the PCMCIA card with the battery charging parameter information, and receiving the second DC power at the second voltage level;

c.2) a cable having a first end coupled to the first connector for transporting the second DC power; and

c.3) a second connector coupled to a second end of the cable for mating with the cellular phone and providing the second DC power to the second battery of cellular phone.

24. In a mobile computing system comprising a cellular phone having a first battery, a method for charging the first battery of cellular phone comprising the steps of:

a) outputting first DC power at a first voltage level by a mobile PC;

b) coupling the first DC power to cellular phone battery charging circuitry disposed in a PCMCIA card coupled to the mobile PC, and providing the cellular phone battery charging circuitry with battery charging parameter information of the first battery of cellular phone using a battery characteristic encoder disposed in a cellular phone adapter cable coupled to the PCMCIA card;

b) converting the first DC power to second DC power at a second voltage level, and outputting the second DC power by the cellular phone battery charging circuitry, in accordance to the battery charging parameter information provided; and

c) coupling the second DC power by the cellular phone adapter cable to the first battery of cellular phone and charging the first battery.

25. The method as set forth in claim 24, wherein

step a) further comprises outputting control signals by the mobile PC for enabling/disabling the cellular phone battery charging circuitry;

step b) further comprises coupling the control signals to the cellular phone battery charging circuitry.

26. The method as set forth in claim 25, wherein step a) is automatically performed by the mobile PC upon detecting a predetermined condition.

27. The method as set forth in claim 26, wherein step a) further comprises continuous monitoring and storing of charge and control status of a second battery of mobile PC in predetermined locations of

mobile PC by mobile PC, and continuously monitoring for whether the predetermined condition has been met by mobile PC.

28. The method as set forth in claim 26, wherein step a) further comprises accepting control inputs, including decisional factors of the predetermined condition, through an user interface by mobile PC.

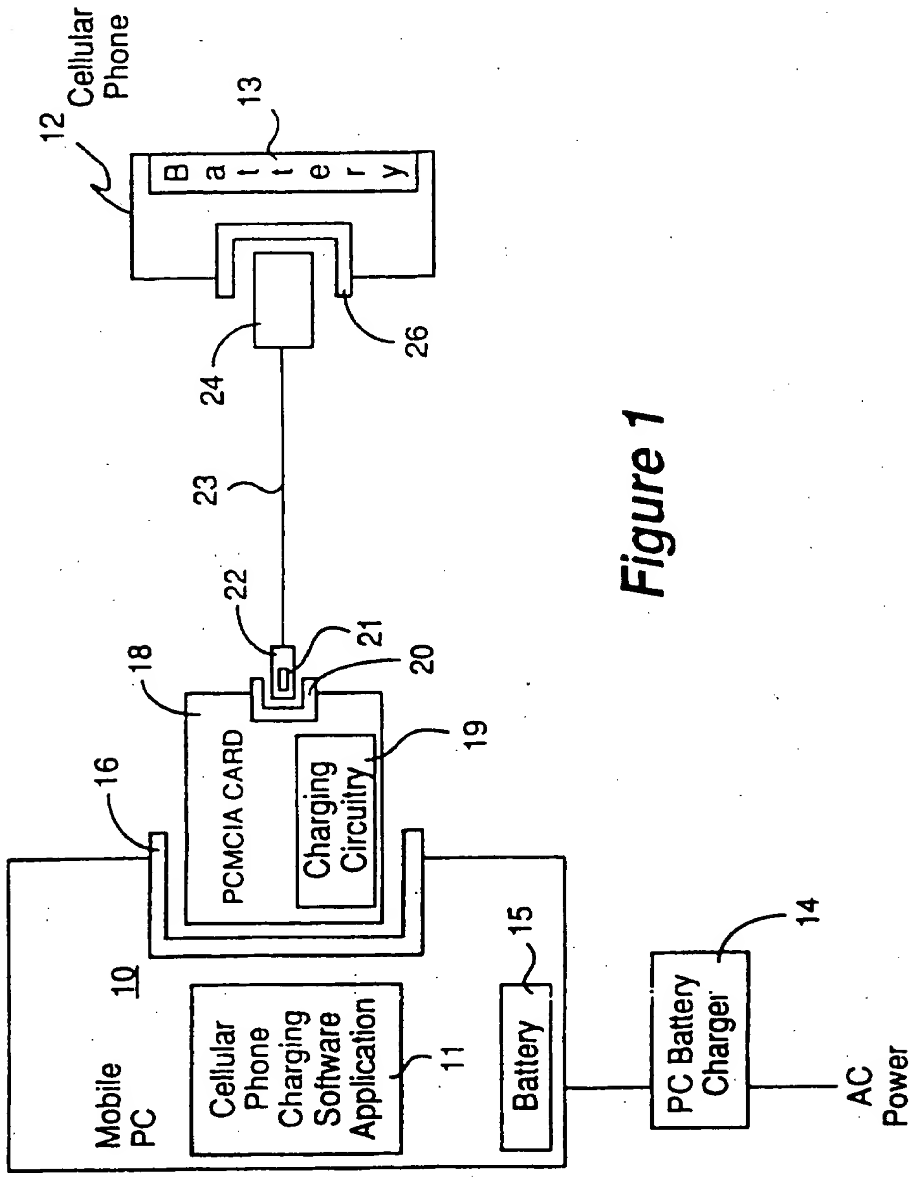

Cellular Phone
12
13
Battery
24
26
23
22
21
20
18
PCMCIA CARD
Charging Circuitry
19
16
Mobile PC
10
Cellular Phone Charging Software Application
11
Battery
15
PC Battery Charger
14
AC Power

Figure 1

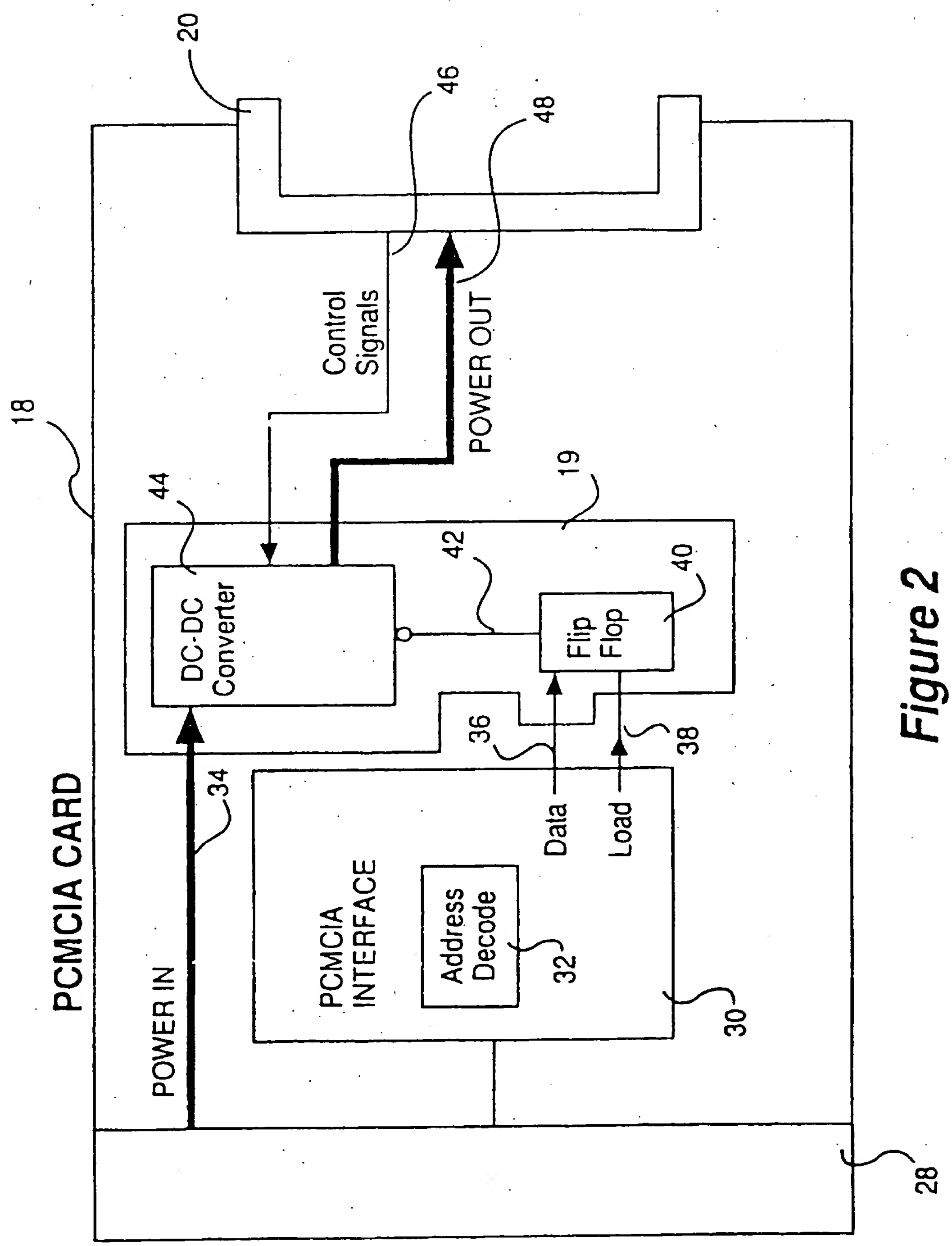

PCMCIA CARD
18
20
46
48
Control Signals
POWER OUT
19
44
DC-DC Converter
42
40
Flip Flop
36
38
34
Data
Load
POWER IN
PCMCIA INTERFACE
Address Decode
32
30
28

Figure 2

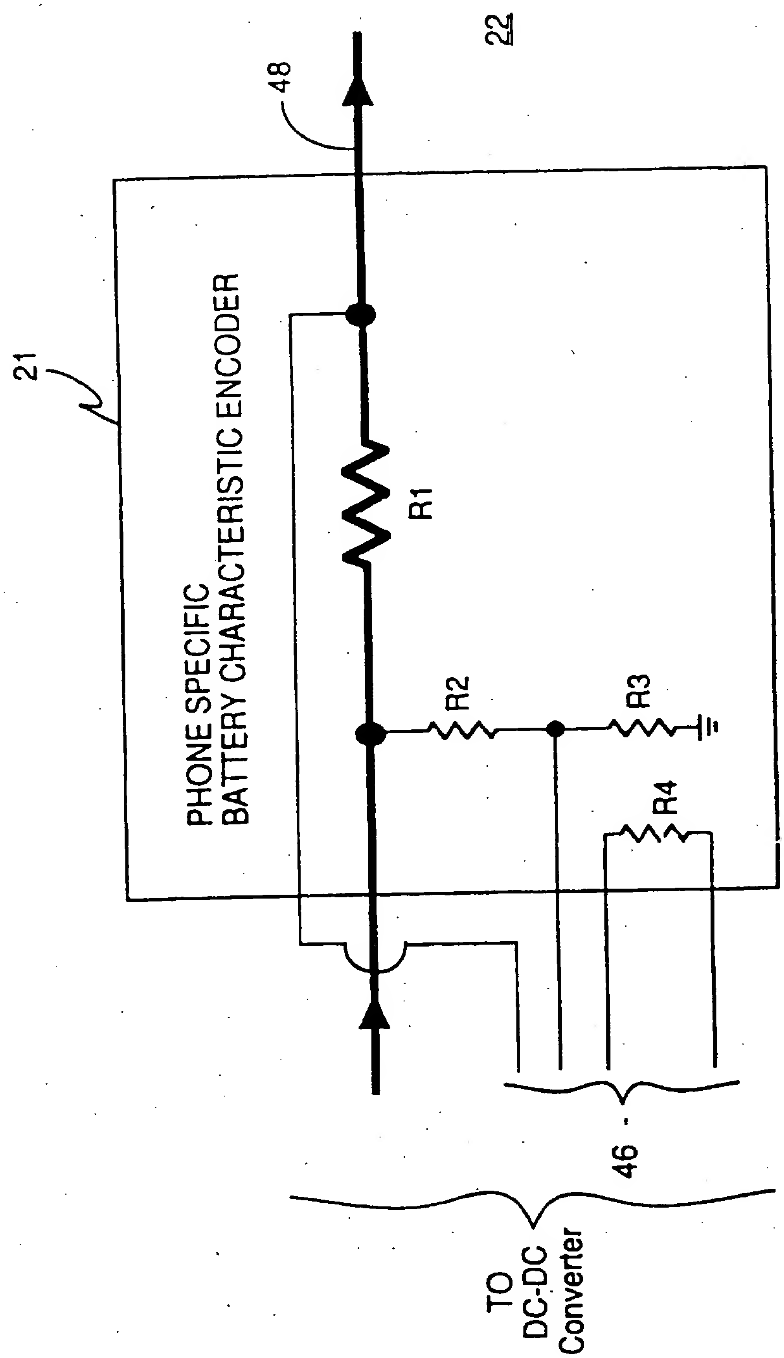

22
48
21
PHONE SPECIFIC
BATTERY CHARACTERISTIC ENCODER
R1
R2
R3
R4
46
TO
DC-DC
Converter

Figure 3a

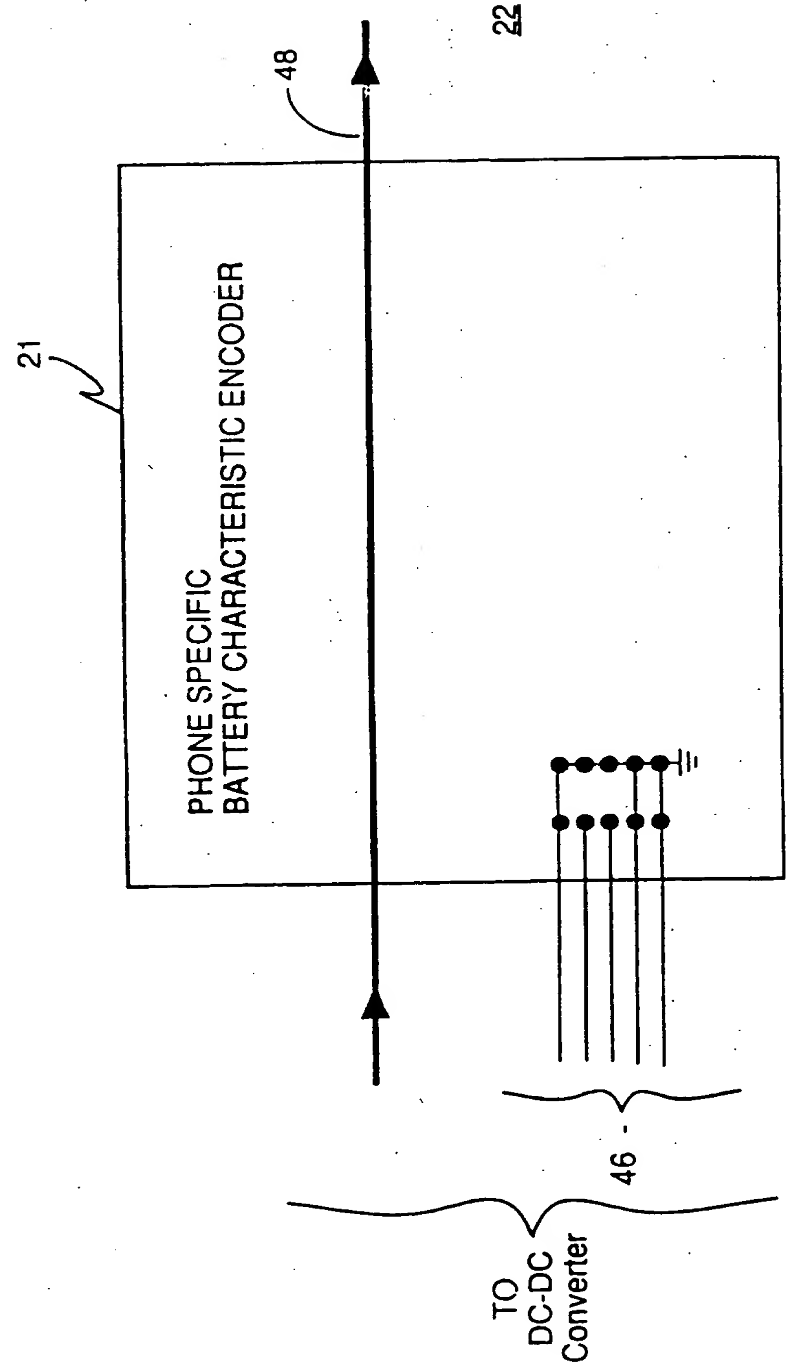

PHONE SPECIFIC
BATTERY CHARACTERISTIC ENCODER
21
48
22
46
TO
DC-DC
Converter

Figure 3b

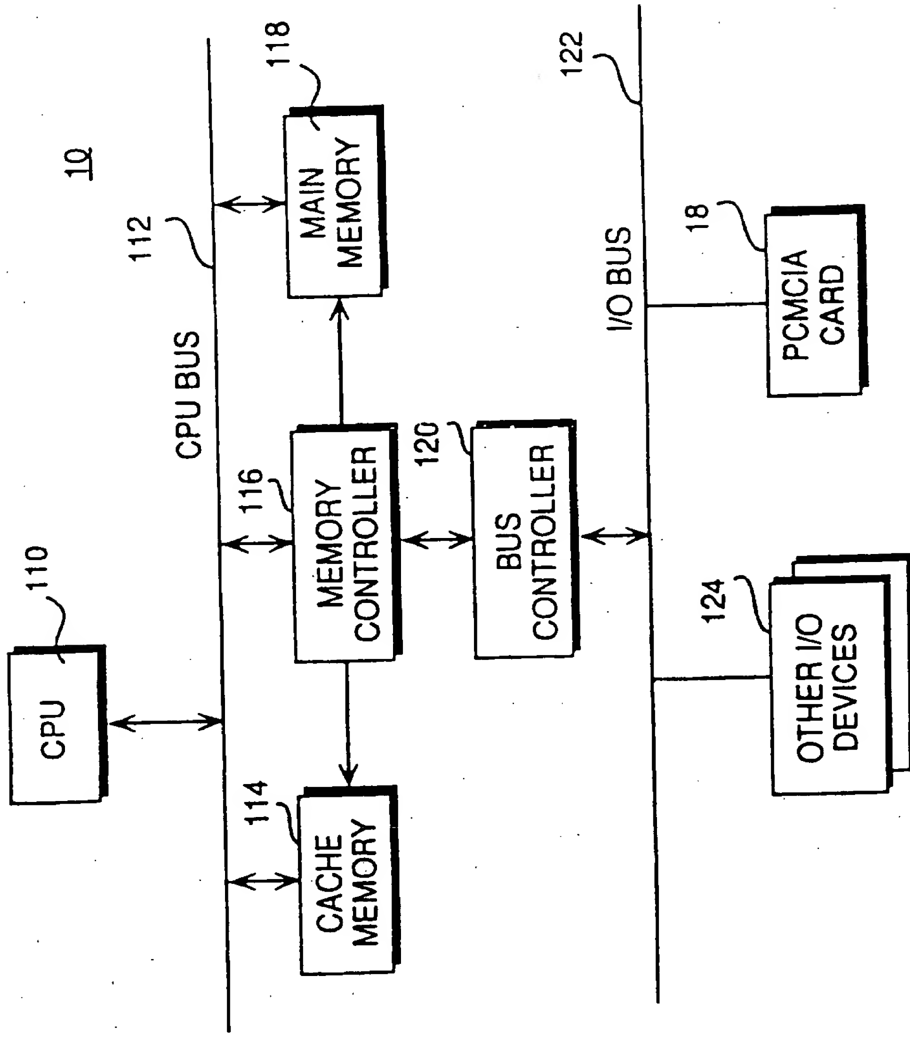
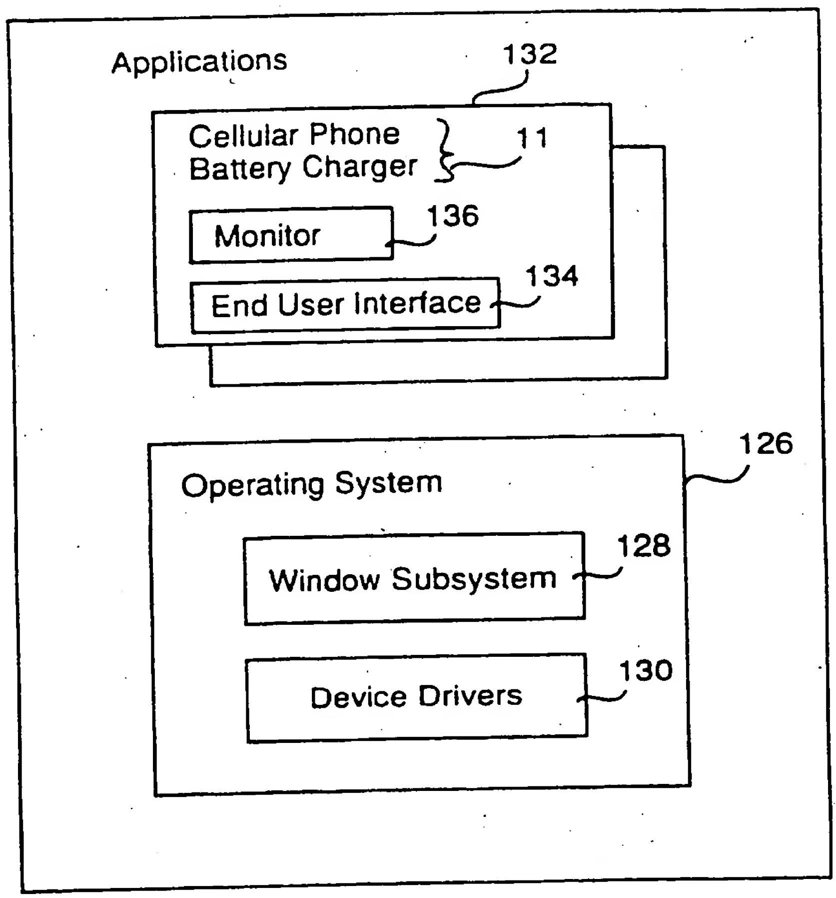

10
CPU
110
CPU BUS
112
MAIN MEMORY
118
MEMORY CONTROLLER
116
CACHE MEMORY
114
BUS CONTROLLER
120
I/O BUS
122
PCMCIA CARD
18
OTHER I/O DEVICES
124

Figure 4



Applications
132
Cellular Phone
Battery Charger
11
Monitor
136
End User Interface
134
Operating System
126
Window Subsystem
128
Device Drivers
130

Figure 5

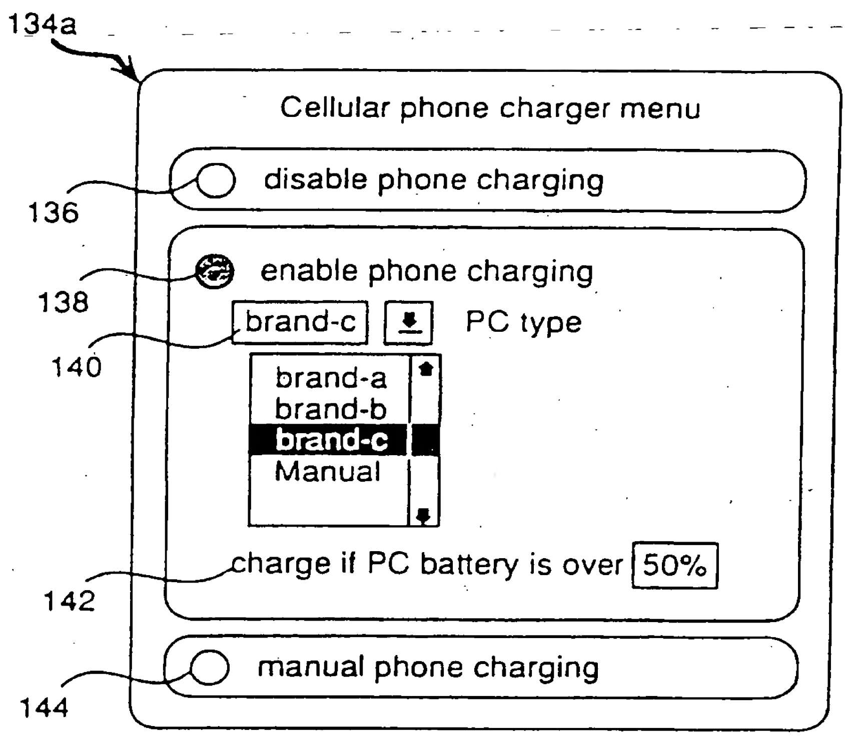


Figure 6a

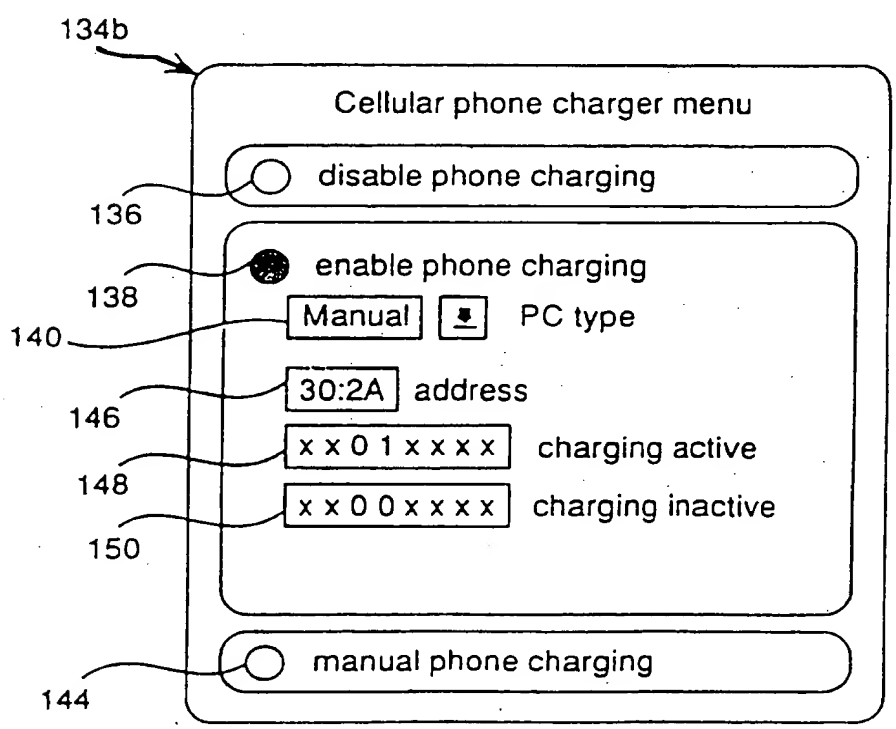


Figure 6b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/16488

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G06F 13/00
US CL :395/750, 835, 882
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 395/700, 821, 835, 882; 361/683; 363/49; 379/59

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, JPOABS, COMPUTER SELECT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,313,642 (SEIGEL) 17 May 1994, Abstract, Detail Description	1 - 28
Y	US, A, 5,375,051 (DECKER ET AL) 20 December 1994, Abstract, Fig. 1, Summary	1 - 28

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

05 MARCH 1996

Date of mailing of the international search report

18 MAR 1996

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